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Software Test Description for the Polar Ice Prediction System 2.0

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13. ABSTRACT *(Maximum 200 words)*

Since 1987, the Fleet Numerical Meteorology and Oceanography Center (FNMOC) has been running sea ice forecasting systems in various regions of Navy interest (the Central Arctic, the Barents Sea, and the Greenland Sea). The Polar Ice Prediction System Version 1.1 predicts sea ice conditions in the Arctic basin, the Barents Sea, and the Greenland Sea at a resolution of 127 km. Two regional sea ice forecast systems, the Polar Ice Prediction System – Barents Sea (RPIPS-B) and the Polar Ice Prediction System – Greenland Sea (RPIPS-G), also predict sea ice conditions in the Barents and Greenland Seas, respectively, at a higher resolution of 20–25 km. In 1995, the Naval Research Laboratory delivered to FNMOC a coupled ice-ocean system, the Polar Ice Prediction System Version 2.0 (PIPS2.0), which predicts sea ice conditions for most of the ice-covered regions in the Northern Hemisphere. PIPS2.0 will replace the three existing operational forecast systems when it completes the final operational testing phase at FNMOC. PIPS2.0 uses as its basis the Hibler ice model and the Cox ocean model. PIPS2.0 has a resolution of approximately a quarter of a degree, which is equivalent to the resolution of the operational regional systems (RPIPS-B and RPIPS-G). This report describes the test cases and test procedures necessary to execute PIPS2.0.

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SOFTWARE TEST DESCRIPTION FOR THE
POLAR ICE PREDICTION SYSTEM 2.0 (PIPS2.0)

1.0 SCOPE

1.1 Identification

This software test description (STD) describes the test cases and test procedures necessary to perform formal qualification testing of the computer software configuration item (CSCI) identified as the Polar Ice Prediction System 2.0 (PIPS2.0). This STD has been prepared in accordance with the guidelines set forth by the Fleet Numerical Meteorology and Oceanography Center (FNMOC). These guidelines are based on the data item description (DID) DI-MCCR-800015A of DOD-STD-2167A.

1.2 System Overview

PIPS2.0 was developed to provide forecasts of ice drift velocity, ice thickness, and ice concentration for most ice-covered regions in the northern hemisphere. This includes the area from the North Pole south to approximately 30° N. Previous operational versions of PIPS relied on an external source for required oceanic forcing. PIPS2.0, however, is largely a self-contained model with the required oceanic forcing being computed within the model itself. Two independent models were merged to form PIPS2.0, *The Hibler Viscous-Plastic Sea Ice Model* (Hibler 1979; 1980), which provides the ice prediction output and *The Cox Ocean Model* (Cox 1984), which provides the ocean forcing required as input for the Hibler Ice Model.

To accomplish the merger, the models were first independently adapted to the required prediction basin (Preller and Posey 1989) and then joined by a common driver routine (Preller et al. 1996). Information between the coupled models is exchanged via common blocks.

1.3 Overview

This STD provides descriptions of the test cases and test procedures necessary to perform formal qualification testing of PIPS2.0. Two test cases are presented: one in which PIPS2.0 is run out for 24 hrs, and the second in which PIPS is run out for 5 days. Pretest hardware and software procedures are provided in Sec. 2.0. Section 3.0 identifies the two test cases and for each, describes the initialization, inputs, expected results, and the procedure for evaluating the results. In Secs. 3.1.5 and 3.2.5 the step-by-step procedure for running the test cases are given. Abbreviations and acronyms used in this document are listed in Sec. 4.0. As per FNMOC Instruction 5234.5, inapplicable paragraphs have been removed and the remaining paragraphs renumbered so that the document paragraph numbers are sequential.

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2.0 FORMAL QUALIFICATION TEST PREPARATIONS

2.1 Test Case 1: 1-Day Forecast Run

2.1.1 Test Case 1: Pretest Procedures

2.1.1.1 Hardware Preparation

PIPS2.0 is designed to run on a UNIX host platform. Host specifics have been kept to a minimum. No hardware preparation is necessary.

2.1.1.2 Software Preparation

The PIPS2.0 software will be provided via disk file. Along with the source code are several include files that must be in the same directory for compilation. The required files are listed below:

Source Code	Include Files (Common Blocks)			Include Files (Parameters)
pips2_final.f	bg.com	levitus.com	rvr.com	ice.par
	corsp.com	mask.com	scalar.com	ocean.par
	cox2.com	oceans.com	snow.com	odam.par
	curnts.com	onedim.com	step.com	qmax.par
	diffu3.com	press.com	stepsp.com	relax.par
	fields.com	rad.com	tstep.com	
	force.com	rfor.com	tstop.com	
	fullwd.com	rfor2.com	worksp1.com	
	grow.com	rstrt.com	worksp2.com	

Create the PIPS2.0 executable **pips2.out** with the UNIX cf77 Fortran compiler. The following compiling command and options are recommended:[1]

```
cf77 -Zp -Wd-l pips2_final.L -q t -Wf-o zeroinc -d p -m 4 pips2_final3.f -o pips2.out
```

2.2 Test Case 2: 5-Day Forecast Runs

2.2.1 Test Case 2: Pretest Procedures

Test Case 2 test preparations are identical to those required for Test Case 1. See Sec. 2.1.1.

---

[1]cf77 options: [-Zp] auto tasking and maximum vectorization; [-Wd"-l *file* -q t"] dependence analyzer names listing file *file*; [-Wf"-o zeroinc -d p -m 4"] Fortran compiler optimizations option assumes constant increment variables can be incremented by zero generating conditional vector code, disable double precision making any double precisions single, and lowest message level of 4 (includes errors, warnings, cautions, notes).

3.0 FORMAL QUALIFICATION TEST DESCRIPTIONS

3.1 Test Case 1: 1-Day Forecast Run

Test Case 1 is run to verify that PIPS2.0 produces the results expected for a typical 24-hr forecast. The run is for Oct 1, 1992. The Navy Operational Global Atmospheric Prediction System (NOGAPS) data for that day and restart files from the previous day (Sep 30, 1992) are input.

3.1.1 Test Case 1: Initialization

Test Case 1 is initialized with the previous day's model run, including the ice and ocean model restart files and the currents for the last two timesteps; and with the monthly river rate and historical Levitus temperatures and salinities. It is forced using NOGAPS atmospheric data. A land/sea mask and a file of gridpoints are also required. All initialization data are provided to PIPS2.0 via disk files.

The initialization files for this first test case are provided as a part of the PIPS2.0 software delivery. The files are:

920930_u.res   PIPS2.0 ice model restart file output from Sep 30, 1992

fort_09.21   PIPS2.0 ocean model restart file output from Sep 30, 1992

for010_09d_u2.dat   PIPS2.0 ocean model output currents from Sep 30, 1992

river_oct.dat   October river rates for the model region

for018_tu_10.dat   Levitus October temperatures interpolated to the model gridpoints

for018_su_10.dat   Levitus October salinities interpolated to the model gridpoints

p921001u.dat   NOGAPS Oct 1, 1992 atmospheric data

mask_u.dat   Land/sea mask for the model grid

newlatu.dat   Latitude/longitude in Earth-oriented spherical coordinates for the model gridpoints

3.1.2 Test Case 1: Test Inputs

Test inputs are entered via the run shellscript. They are entered directly following the program execution command as free-format input in a prescribed order. The following five inputs are required (their test case input values are in brackets):

itstep   [8   ] Number of timesteps for run

pltstp   [8   ] Interval in timesteps at which to plot

prtstp   [8   ] Interval in timesteps at which to print

irstrt   [1   ] Restart indicator; 1 for restart, 0 for climatology restart

idtg   [92100100] 8-character date-time-group of the model run, YYMMDDHH

The input values must be entered in the following order (commas are optional):

itstep, pltstp, prtstp, irstrt, idtg

3.1.3 Test Case 1: Expected Test Results
3.1.3.1 Screen Output

Screen data provides a quick look at the PIPS2.0 run. Displayed are ice thickness, ice outflow, and ice growth rate values, as well as intermediate timestep information. Portions of the expected screen output from Test Case 1 is shown in App. A.

3.1.3.2 File Output

Test Case 1 files output include a file formatted specifically for post PIPS2.0 graphics plotting, a currents file that may be used for plotting but is also used for initialization of the next model run, and two restart files, one from the ocean model portion of PIPS2.0 and the other from the ice model portion. Both restart files are used solely as restart initialization data for the next day's model run. The four files output from Test Case 1 are:

921001_final.dat   Graphics data

for010_1001_final.dat Ocean model output currents

fort_921001_final.21   Ocean model restart data

921001_final.res   Ice model restart data

Geostrophic wind, ice thickness, ice drift, ice concentration, ocean current, and ocean temperature results for the last timestep of Test Case 1 are shown in App. B, Figs. B-1 through B-6, respectively. These results are instantaneous values and are not averaged over the course of the day. Units of each are listed on the plot, except for ice concentration, which is in percentage of cell covered with ice.

Two points on the model grid have been chosen from these plots to extract quantitative values of the model results. Point 1 (142,126) is located in the Beaufort Sea area and point 2 (202,166) is located in the Central Arctic. The locations of the points are shown on the hatched grid showing every fourth gridpoint in Fig. 1. Expected results for the two points are shown in Table 1.

3.1.4 Test Case 1: Criteria for Evaluating Results

Test Case 1 results are evaluated by comparing output data plots and by comparing selected output data values. Wind, ice, and ocean current velocity vectors; ice thickness and ice concentration contours; and temperature contours at 15 m should coincide with the vectors and contours displayed in App. B. Extracted data values from the output graphics and ocean currents files should match those listed in Table 1 to the accuracy presented.

3.1.5 Test Case 1: Test Procedure

The Test Case 1 procedure consists of running the PIPS2.0 model (steps 1 through 4), and then extracting output to be used in the comparison of the expected results (steps 5 and 6). It is convenient
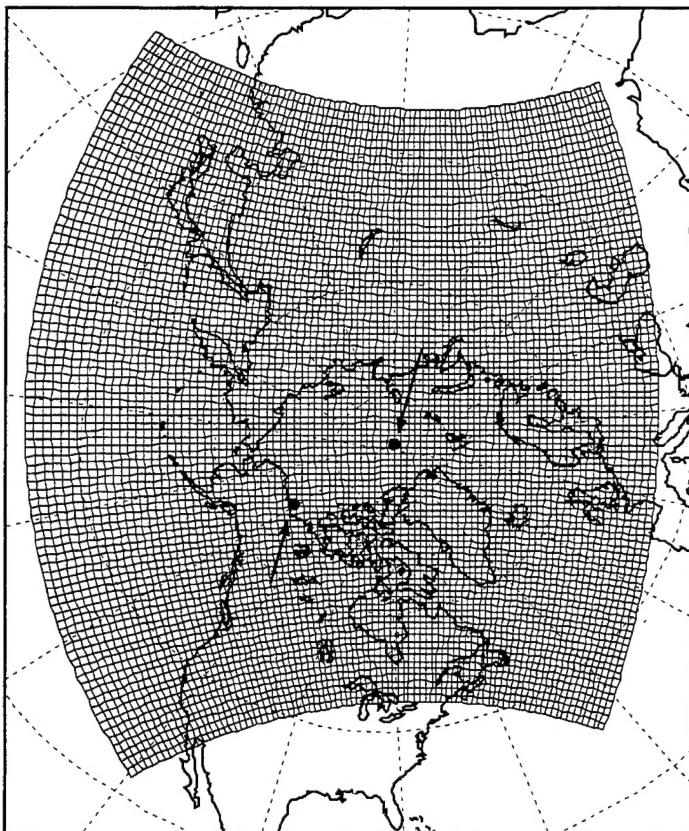
Fig. 1 — PIPS2.0 model grid showing locations of points 1 and 2

Table 1 — Expected Model Output Values for Points 1 and 2

	Point 1 (142,126)	Point 2 (202,166)
u component of geostrophic wind (m/s)	–3.60765	12.3593
v component of geostrophic wind (m/s)	7.77270	6.88655
ice thickness (m)	4.39412E-02	3.08821
u component of ice drift (m/s)	–2.23710E-02	0.197808
v component of ice drift (m/s)	6.41437E-02	3.06618E-02
ice concentration (1:100%)	0.166745	0.844092

to use a shellscript to perform the functions necessary for running PIPS2.0. Appendix C contains the shellscript that may be used for running Test Case 1. It is assumed that this shellscript is located in the same directory as the executable and the input and output files. Path names would have to be included with filenames if different directories are used.

1) Assign the logical units used for PIPS2.0 execution. Begin by clearing any logical units that were previously assigned using the **assign -R** command.

```
assign -R
```

Then assign the unit numbers to be used by PIPS2.0 as ieee data format using the following command:

```
assign -F f77 -N ieee u:<unit #>
```

Repeat the command for unit numbers 10 through 16 and 30, 31, and 33.

2) Assign the input data files to specific logical unit numbers:

File	Unit #
for018_tu_10.dat	10
for018_su_10.dat	11
p921001u.dat	12
for010_09d_u2.dat	13
newlatu.dat	14
mask_u.dat	15
920930_u.res	16
fort_09.21	18
river_oct.dat	19

This may done in UNIX using the **ln** command, linking a file to the default file for the specific logical unit number.

```
ln <filename > fort.<unit#>
```

3).Run the model. Enter the model execution name, followed by the input data values.

```
pips2_c.out

8   8   8   1   92100100
```

4) Output data is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

Unit #	File
30	for010_1001_final.dat
31	921001_final.dat
32	921001_final.res
33	fort_921001_final.21

This renaming may be done in UNIX using the **mv** command, moving a file out of its default logical unit filename to its new filename.

```
mv fort.<unit#> <filename >
```

5) Use externally supplied routines to generate output plots. Four plots are made using data from the graphics output file *921001_final.dat*, and two plots are made using data from the ocean model currents file *for010_1001_final.dat*. Table 2 lists plots and the output fields from the files to be plotted. The *921001_final.dat* and *for010_1001_final.dat* file formats are provided in App. D.

6) Using externally supplied software, extract values for point 1 (142,126) and point 2 (202,166) of the u component of geostrophic wind, the v component of geostrophic wind, ice thickness, the u component of ice drift, the v component of ice drift, and ice concentration from the graphics file *921001_final.dat*. The fields to extract from are the same as those listed in Table 2.

3.1.6 Test Case 1: Assumptions and Constraints

It is assumed that externally supplied graphics software is available for generating output plots. There are no additional assumptions and constraints.

3.2 Test Case 2: 5-Day Forecast Runs

Test Case 2 is run to verify that PIPS2.0 continues to produce the results expected for a succession of daily forecasts. Relying upon the forecast and restart files output from Test Case 1, PIPS2.0 is run for 4 additional days. NOGAPS data for the 4 days and the restart files from Test Case 1 are input.

Table 2 — Output Plotting Data Fields for Test Case 1

Plot	File	Fields
Geostrophic wind vectors with a maximum vector of approximately 3/4" representing 0.500E +02 m/s	921001_final.dat	GAIRX, GAIRY
Ice thickness contours from 0.2 to 6.0 m with a contour interval of 0.2 m	921001_final.dat	HEFF
Ice velocity vectors with a maximum vector of approximately 3/4" representing 0.300E+02 cm/s	921001_final.dat	UICE, VICE
Ice concentration contours from 0.2 to 1.0 with a contour interval of 0.1 (1:100%)	921001_final.dat	AREA1
Ocean current vectors with a maximum vector of approximately 3/4" representing 0.200E+02 cm/s	for010_1001_final.dat	UTEMP, VTEMP
Temperature contours at 15 m from –2.0 to 28.0°C with a contour interval of 1.0°C	for010_1001_final.dat	TMP

3.2.1 Test Case 2: Initialization

Test Case 2 is initialized with the model output from Test Case 1 and with the monthly river rate and historical Levitus temperatures and salinities. It is forced using NOGAPS atmospheric data. The land/sea mask and file of gridpoints are also required. All initialization data are provided to PIPS2.0 via disk files.

The initialization files, other than the Test Case 1 output files, are provided as a part of the PIPS2.0 software delivery. The river rates, land/sea mask, and gridpoints are the same files input for Test Case 1. The initialization files are:

921001_final.res	PIPS2.0 ice model restart file output Test Case 1
fort_921001_final.21	PIPS2.0 ocean model restart file output from Test Case 1
for010__1001_final.dat	PIPS2.0 ocean model output currents from Test Case 1
river_oct.dat	October river rates for the model region
for018_tu_10.dat	Levitus October temperatures interpolated to the model gridpoints
for018_su_10.dat	Levitus October salinities interpolated to the model gridpoints
p921002u.dat	NOGAPS Oct 2, 1992 atmospheric data
p921003u.dat	NOGAPS Oct 3, 1992 atmospheric data
p921004u.dat	NOGAPS Oct 4, 1992 atmospheric data
p921005u.dat	NOGAPS Oct 5, 1992 atmospheric data
mask_u.dat	Land/sea mask for the model grid
newlatu.dat	Latitude/longitude in Earth-oriented spherical coordinates for the model gridpoints

3.2.2 Test Case 2: Test Inputs

Test inputs are entered via the run shellscript. Four input values are entered directly following each run execution as free-format input in a prescribed order. The following five inputs, in order, are required (the values for each run are shown in brackets):

		Run 1	Run 2	Run 3	Run 4
itstep	Number of timesteps for run	[8]	[8]	[8]	[8]
pltstp	Interval in timesteps at which to plot	[8]	[8]	[8]	[8]
prtstp	Interval in timesteps at which to write	[8]	[8]	[8]	[8]
irstrt	Restart indicator; 1 for restart, 0 for climatology restart	[8]	[8]	[8]	[8]
idtg	8-character date-time-group of the model run, YYMMDDHH	[92100200]	[92100300]	[92100400]	[92100500]

3.2.3 Test Case 2: Expected Test Results

3.2.3.1 Screen Output

Screen data provides a quick look at the PIPS2.0 run. Displayed are ice thickness, outflow, and ice growth rate values, as well as intermediate timestep information. Portions of the expected screen output from Test Case 2 is shown in App. E.

3.2.3.2 File Output

Each of the four PIPS2.0 runs in Test Case 2 produce four output files. The files for each run include a file formatted specifically for post PIPS2.0 graphics plotting, a currents file that may be used for plotting but is also used for initialization of the next model run, and two restart files, one from the ocean model portion of PIPS and the other from the ice model portion. Restart files are used solely as restart initialization data for the next day's model run. The four sets of files output from the Test Case 2 are:

Ice Restart Data	Ocean Restart Data	Ocean Output Currents	Graphics Data
921002_final.res	*fort_921002_final.21*	*for010_1002_final.dat*	*921002_final.dat*
921003_final.res	*fort_921003_final.21*	*for010_1003_final.dat*	*921003_final.dat*
921004_final.res	*fort_921004_final.21*	*for010_1004_final.dat*	*921004_final.dat*
921005_final.res	*fort_921005_final.21*	*for010_1005_final.dat*	*921005_final.dat*

Geostrophic wind, ice thickness, ice drift, ice concentration, ocean current, and ocean temperature results for the last timestep of the last day (day 5) of Test Case 2 are shown in App. F, Figs. F-1 through F-6, respectively. These results are instantaneous values and are not averaged over the course of the day. Units of each are listed on the plot, except for ice concentration, which is in percentage of cell covered with ice.

The same two points on the model grid that were chosen in Test Case 1 have been chosen to extract quantitative values from the fifth day's plots. The locations of the points were shown on the hatched grid showing every fourth gridpoint in Sec. 3.1.3, Fig. 1. Expected results from day 5 for the two points are shown below in Table 3.

Table 3 — Expected Model Output Values for Day 5, Points 1 and 2

	Point 1 (142,126)	Point 2 (202,166)
u component of geostrophic wind (m/s)	−0.615954	0.829795
v component of geostrophic wind (m/s)	−3.84163	−3.98314
ice thickness (m)	0.187806	3.05782
u component of ice drift (m/s)	02.27331E-02	3.16991E-02
v component of ice drift (m/s)	2.66174E-02	−5.75908E-02
ice concentration (1:100%)	0.268280	0.833614

3.2.4 Test Case 2: Criteria for Evaluating Results

Test Case 2 results are evaluated by comparing output data plots and by comparing selected output data values. Wind, ice, and ocean current velocity vectors; ice thickness and ice concentration contours; and temperature contours at 15 m should coincide with the vectors and contours displayed in App. F. Extracted data values from the output graphics and ocean currents files should match those listed in Table 3 to the accuracy presented.

3.2.5 Test Case 2: Test Procedure

The Test Case 2 procedure is very similar to Test Case 1, except that PIPS2.0 is run four times. Each time it is run, the input and output filenames must be attached to the correct logical unit numbers. The procedure consists of the runnings of PIPS2.0 (steps 1 through 13), and then extracting output to be used in the comparison of the expected results (steps 14 and 15). A shellscript is suggested to perform the functions necessary for the model runs. Appendix G contains the shellscript that may be used for running Test Case 2. It is assumed that this shellscript is located in the same directory as the executable and the input and output files. Path names would have to be included with filenames if different directories are used.

1) Assign the logical units used for PIPS2.0 execution. Begin by clearing any logical units that were previously assigned using the **assign -R** command.

```
assign -R
```

Then assign the unit numbers to be used by PIPS2.0 as ieee data format using the following command:

```
assign -F f77 -N ieee u:<unit #>
```

Repeat the command for unit numbers 10 through 15 and 30 and 31.

2) Assign the input data files for run 1 to specific logical unit numbers:

File	Unit #
for018_tu_10.dat	10
for018_su_10.dat	11
p921002u.dat	12
for010_1001_final.dat	13
newlatu.dat	14
mask_u.dat	15
921001_final.res	16
fort_921001_final.21	18
river_oct.dat	19

This may be done in UNIX using the **ln** command, linking a file to the default file for the specific logical unit number.

---

ln <*filename* > fort.<*unit#*>

---

3) Run the model. Enter the model execution name, followed by the input data values for run 1.

---

pips2_c.out

8   8   8   1   92100200

---

4) Intermediate output data from run 1 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

Unit #	File
30	for010_1002_final.dat
31	921002_final.dat
32	921002_final.res
33	fort_921002_final.21

This renaming may be done in UNIX using the **mv** command, moving a file out of its default logical unit filename to its new filename.

---

mv fort.<*unit#*> <*filename* >

---

5) Assign the input data files for run 2 to specific logical unit numbers:

File	Unit #
for018_tu_10.dat	10
for018_su_10.dat	11
p921003u.dat	12
for010_1002_final.dat	13
newlatu.dat	14
mask_u.dat	15
921002_final.res	16
fort_921002_final.21	18
river_oct.dat	19

This may be done in UNIX using the **ln** command, linking a file to the default file for the specific logical unit number.

6) Run the model. Enter the model execution name, followed by the input data values for run 2.

```
pips2_c.out

8   8   8   1   92100300
```

7) Intermediate output data from run 2 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

Unit #	File
30	for010_1003_final.dat
31	921003_final.dat
32	921003_final.res
33	fort_921003_final.21

This renaming may be done in UNIX using the **mv** command, moving a file out of its default logical unit filename to its new filename.

8) Assign the input data files for run 3 to specific logical unit numbers:

File	Unit #
for018_tu_10.dat	10
for018_su_10.dat	11
p921004u.dat	12
for010_1003_final.dat	13
newlatu.dat	14
mask_u.dat	15
921003_final.res	16
fort_921003_final.21	18
river_oct.dat	19

This may be done in UNIX using the **ln** command, linking a file to the default file for the specific logical unit number.

9) Run the model. Enter the model execution name, followed by the input data values for run 3.

```
pips2_c.out

8   8   8   1   92100400
```

10) Intermediate output data from run 3 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

Unit #	File
30	for010_1004_final.dat
31	921004_final.dat
32	921004_final.res
33	fort_921004_final.21

This renaming may be done in UNIX using the **mv** command, moving a file out of its default logical unit filename to its new filename.

11) Assign the input data files for run 4 to specific logical unit numbers:

File	Unit #
for018_tu_10.dat	10
for018_su_10.dat	11
p921005u.dat	12
for010_1004_final.dat	13
newlatu.dat	14
mask_u.dat	15
921004_final.res	16
fort_921004_final.21	18
river_oct.dat	19

This may be done in UNIX using the **ln** command, linking a file to the default file for the specific logical unit number.

12) Run the model. Enter the model execution name, followed by the input data values for run 4.

```
pips2_c.out

8   8   8   1   92100500
```

13) The final output data for Test Case 2 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

Unit #	File
30	for010_1005_final.dat
31	921005_final.dat
32	921005_final.res
33	fort_921005_final.21

This renaming may be done in UNIX using the **mv** command, moving a file out of its default logical unit filename to its new filename.

14) Use externally supplied routines to generate output plots. Four plots are made using data from the graphics output file, *921005_final.dat*, and two plots are made using data from the ocean model currents file, *for010_1005_final.dat*. Table 4 lists plots and the output fields from the files to be plotted. The *921005_final.dat* and *for010_1005_final.dat* file formats are provided in App. D.

16) Using externally supplied software, extract values for point 1 (142,126) and point 2 (202,166) of the u component of geostrophic wind, the v component of geostrophic wind, ice thickness, the u component of ice drift, the v component of ice drift, and ice concentration from the graphics file, *921005_final.dat*. The fields to extract from are the same as those listed in Table 4.

3.2.6 Test Case 2: Assumptions And Constraints

For Test Case 2, it is assumed that its execution follows Test Case 1 and that the results from Test Case 1 were evaluated and found to be correct. As in Test Case 1, it is assumed that externally supplied graphics software is available for generating output plots.

4.0 NOTES

4.1 Abbreviations and Acronyms

CSCI   Computer Software Configuration Item

DID   Data Item Description

FNMOC   Fleet Numerical Meteorology and Oceanography Center

Table 4 — Output Plotting Data Fields for Test Case 2

Plot	File	Fields
Geostrophic wind vectors with a maximum vector of approximately 3/4" representing 0.500E +02 m/s	921005_final.dat	GAIRX, GAIRY
Ice thickness contours from 0.2 to 6.0 m with a contour interval of 0.2 m	921005_final.dat	HEFF
Ice velocity vectors with a maximum vector of approximately 3/4" representing 0.300E+02 cm/s	921005_final.dat	UICE, VICE
Ice concentration contours from 0.2 to 1.0 with a contour interval of 0.1 (1:100%)	921005_final.dat	AREA1
Ocean current vectors with a maximum vector of approximately 3/4" representing 0.200E+02 cm/s	for010_1005_final.dat	UTEMP, VTEMP
Temperature contours at 15 m from −2.0 to 28.0°C with a contour interval of 1.0°C	for010_1005_final.dat	TMP

I/O	input/output
NOAA	National Oceanic and Atmospheric Administration
NOGAPS	Navy Operational Global Atmospheric Prediction System
NRL	Naval Research Laboratory
PIPS2.0	Polar Ice Prediction System 2.0
SDD	Software Design Document
STD	Software Test Description

5.0 SUMMARY AND CONCLUSIONS

Since 1987, FNMOC has been running sea ice forecasting systems in various regions of Navy interest (the Central Arctic, the Barents Sea, and the Greenland Sea). The PIPS1.1 system predicts sea ice conditions in the Arctic basin, the Barents Sea, and the Greenland Sea at a resolution of 127 km. Two regional sea ice forecast systems, the Polar Ice Prediction System – Barents Sea (RPIPS-B) and the Polar Ice Prediction System – Greenland Sea (RPIPS-G), also predict sea ice conditions in the Barents and the Greenland Seas, respectively, at a higher resolution of 20–25 km. In 1995, NRL delivered to FNMOC a coupled ice-ocean system, PIPS2.0, which predicts sea ice conditions for most of the ice-covered regions in the Northern Hemisphere. PIPS2.0 will replace the existing three operational forecast systems when it completes the final operational testing phase at FNMOC. PIPS2.0 uses as its basis the Hibler ice model (Hibler 1979, 1980) and the Cox ocean model (Cox 1984). PIPS2.0 has a resolution of approximately a quarter of a degree, which is equivalent to the resolution of the operational regional systems and each of its subroutines.

6.0 ACKNOWLEDGMENT

7.0 REFERENCES

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Commander, Space and Naval Warfare Systems Command COMSPAWARSYSCOM-3212, Military Standard, Defense System Software Development DOD STD-2167A, Washington, D.C., 29 Feb, 1988.

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Preller, R. H., P. G. Posey, M. S. Murphy, and A. M. Weimer, "Software Design Document for the Polar Ice Prediction System Version 2.0," NRL/FR/7322--95-9637, Naval Research Laboratory, Stennis Space Center, MS, 1996.

Appendix A

SCREEN OUTPUT FROM TEST CASE 1

```
NO OF ITERATIONS ARE:   842
MAX ERROR FOR U AND V:  0.49885E-05

NO OF ITERATIONS ARE:   454
MAX ERROR FOR U AND V:  0.49907E-05

NO OF ITERATIONS ARE:   322
MAX ERROR FOR U AND V:  0.49858E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,              MAX CHANGE
   64.3837613297      23.6835554931      0.986448997194
0TIME STEP -    1      IDTG -92100100
 1
TS= 13105  YEAR=   0.75  DAY=273.0  ENERGY= 7.499125EΔ∞1  DTEMP= 4.259456E-08  DSALT=
5.296078E-13  SCANS=  9
 TS= 13106  YEAR=   0.75  DAY=273.0  ENERGY= 7.499125E-01  DTEMP= 4.206545E-08  DSALT=
4.636091E-13  SCANS=  9
 TS= 13107  YEAR=   0.75  DAY=273.1  ENERGY= 7.499124E-01  DTEMP= 4.211986E-08  DSALT=
4.709168E-13  SCANS=  8
 TS= 13108  YEAR=   0.75  DAY=273.1  ENERGY= 7.499140E-01  DTEMP= 4.204583E-08  DSALT=
4.643297E-13  SCANS=  4
 TS= 13109  YEAR=   0.75  DAY=273.1  ENERGY= 7.499198E-01  DTEMP= 4.206418E-08  DSALT=
4.685972E-13  SCANS=  5
 TS= 13110  YEAR=   0.75  DAY=273.1  ENERGY= 7.499276E-01  DTEMP= 4.202412E-08  DSALT=
4.654541E-13  SCANS=  4

NO OF ITERATIONS ARE:   590
MAX ERROR FOR U AND V:  0.49924E-05

NO OF ITERATIONS ARE:   524
MAX ERROR FOR U AND V:  0.49585E-05

NO OF ITERATIONS ARE:   344
MAX ERROR FOR U AND V:  0.49691E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,              MAX CHANGE
   163.650461573      42.5260679429      1.90411449951
0TIME STEP -    2      IDTG -92100103
 1
```

TS= 13111 YEAR= 0.75 DAY=273.1 ENERGY= 7.499540E-01 DTEMP= 2.498667E-08 DSALT=
1.127785E-12 SCANS= 7
TS= 13112 YEAR= 0.75 DAY=273.2 ENERGY= 7.499540E-01 DTEMP= 2.441735E-08 DSALT=
1.056485E-12 SCANS= 7
TS= 13113 YEAR= 0.75 DAY=273.2 ENERGY= 7.499727E-01 DTEMP= 2.447353E-08 DSALT=
1.063122E-12 SCANS= 4
TS= 13114 YEAR= 0.75 DAY=273.2 ENERGY= 7.499913E-01 DTEMP= 2.440174E-08 DSALT=
1.055803E-12 SCANS= 4
TS= 13115 YEAR= 0.75 DAY=273.2 ENERGY= 7.500136E-01 DTEMP= 2.442698E-08 DSALT=
1.059808E-12 SCANS= 3
TS= 13116 YEAR= 0.75 DAY=273.3 ENERGY= 7.500346E-01 DTEMP= 2.438918E-08 DSALT=
1.055728E-12 SCANS= 4

NO OF ITERATIONS ARE: 349
MAX ERROR FOR U AND V: 0.49425E-05

NO OF ITERATIONS ARE: 360
MAX ERROR FOR U AND V: 0.49731E-05

NO OF ITERATIONS ARE: 219
MAX ERROR FOR U AND V: 0.49668E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,   MAX CHANGE
   179.759728470   137.007813316   4.69987748431
0TIME STEP -   3   IDTG -92100106
1
TS= 13117 YEAR= 0.75 DAY=273.3 ENERGY= 7.500827E-01 DTEMP= 2.932740E-08 DSALT=
5.379423E-13 SCANS= 4
TS= 13118 YEAR= 0.75 DAY=273.3 ENERGY= 7.500827E-01 DTEMP= 2.875357E-08 DSALT=
4.660885E-13 SCANS= 4
TS= 13119 YEAR= 0.75 DAY=273.3 ENERGY= 7.501069E-01 DTEMP= 2.881068E-08 DSALT=
4.735197E-13 SCANS= 4
TS= 13120 YEAR= 0.75 DAY=273.3 ENERGY= 7.501317E-01 DTEMP= 2.873786E-08 DSALT=
4.666676E-13 SCANS= 5
TS= 13121 YEAR= 0.75 DAY=273.4 ENERGY= 7.501556E-01 DTEMP= 2.876242E-08 DSALT=
4.711978E-13 SCANS= 4
TS= 13122 YEAR= 0.75 DAY=273.4 ENERGY= 7.501795E-01 DTEMP= 2.872376E-08 DSALT=
4.676426E-13 SCANS= 4

NO OF ITERATIONS ARE: 481
MAX ERROR FOR U AND V: 0.49672E-05

NO OF ITERATIONS ARE: 384
MAX ERROR FOR U AND V: 0.49542E-05

NO OF ITERATIONS ARE: 255
MAX ERROR FOR U AND V: 0.49961E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,   MAX CHANGE
   184.206614082   68.2583842359   1.19808153307
0TIME STEP -   4   IDTG -92100109
1

TS= 13123 YEAR= 0.75 DAY=273.4 ENERGY= 7.502247E-01 DTEMP= 2.743758E-08 DSALT= 5.476528E-13 SCANS= 4
TS= 13124 YEAR= 0.75 DAY=273.4 ENERGY= 7.502247E-01 DTEMP= 2.683961E-08 DSALT= 4.704995E-13 SCANS= 4
TS= 13125 YEAR= 0.75 DAY=273.4 ENERGY= 7.502452E-01 DTEMP= 2.689894E-08 DSALT= 4.781985E-13 SCANS= 4
TS= 13126 YEAR= 0.75 DAY=273.5 ENERGY= 7.502664E-01 DTEMP= 2.682667E-08 DSALT= 4.713687E-13 SCANS= 5
TS= 13127 YEAR= 0.75 DAY=273.5 ENERGY= 7.502856E-01 DTEMP= 2.685248E-08 DSALT= 4.759470E-13 SCANS= 5
TS= 13128 YEAR= 0.75 DAY=273.5 ENERGY= 7.503057E-01 DTEMP= 2.681414E-08 DSALT= 4.723406E-13 SCANS= 5

NO OF ITERATIONS ARE: 468
MAX ERROR FOR U AND V: 0.49850E-05

NO OF ITERATIONS ARE: 343
MAX ERROR FOR U AND V: 0.49239E-05

NO OF ITERATIONS ARE: 281
MAX ERROR FOR U AND V: 0.49223E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
199.780837775 107.676099214 1.29458885460
0TIME STEP - 5 IDTG -92100112 1
TS= 13129 YEAR= 0.75 DAY=273.5 ENERGY= 7.503446E-01 DTEMP= 2.941340E-08 DSALT= 5.530029E-13 SCANS= 5
TS= 13130 YEAR= 0.75 DAY=273.5 ENERGY= 7.503447E-01 DTEMP= 2.883928E-08 DSALT= 4.811789E-13 SCANS= 5
TS= 13131 YEAR= 0.75 DAY=273.6 ENERGY= 7.503646E-01 DTEMP= 2.889776E-08 DSALT= 4.891239E-13 SCANS= 4
TS= 13132 YEAR= 0.75 DAY=273.6 ENERGY= 7.503854E-01 DTEMP= 2.882578E-08 DSALT= 4.824433E-13 SCANS= 5
TS= 13133 YEAR= 0.75 DAY=273.6 ENERGY= 7.504062E-01 DTEMP= 2.884888E-08 DSALT= 4.862763E-13 SCANS= 4
TS= 13134 YEAR= 0.75 DAY=273.6 ENERGY= 7.504280E-01 DTEMP= 2.881341E-08 DSALT= 4.833621E-13 SCANS= 4

NO OF ITERATIONS ARE: 451
MAX ERROR FOR U AND V: 0.49823E-05

NO OF ITERATIONS ARE: 331
MAX ERROR FOR U AND V: 0.49262E-05

NO OF ITERATIONS ARE: 292
MAX ERROR FOR U AND V: 0.49405E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
201.567416329 86.1071302330 1.75555531729 0TIME STEP - 6 IDTG -92100115
1

 TS= 13135 YEAR=   0.75 DAY=273.6 ENERGY= 7.504754E-01 DTEMP= 2.696963E-08 DSALT=
5.738526E-13 SCANS= 5
 TS= 13136 YEAR=   0.75 DAY=273.7 ENERGY= 7.504754E-01 DTEMP= 2.628854E-08 DSALT=
4.920304E-13 SCANS= 5
 TS= 13137 YEAR=   0.75 DAY=273.7 ENERGY= 7.505024E-01 DTEMP= 2.623886E-08 DSALT=
4.902659E-13 SCANS= 5
 TS= 13138 YEAR=   0.75 DAY=273.7 ENERGY= 7.505304E-01 DTEMP= 2.616848E-08 DSALT=
4.836784E-13 SCANS= 4
 TS= 13139 YEAR=   0.75 DAY=273.7 ENERGY= 7.505608E-01 DTEMP= 2.619355E-08 DSALT=
4.880454E-13 SCANS= 4
 TS= 13140 YEAR=   0.75 DAY=273.8 ENERGY= 7.505920E-01 DTEMP= 2.616017E-08 DSALT=
4.853268E-13 SCANS= 5

 NO OF ITERATIONS ARE: 444
 MAX ERROR FOR U AND V: 0.49549E-05

 NO OF ITERATIONS ARE: 293
 MAX ERROR FOR U AND V: 0.48847E-05

 NO OF ITERATIONS ARE: 258
 MAX ERROR FOR U AND V: 0.49266E-05

 SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,   MAX CHANGE
    213.781007584   135.269304186   2.52517726506
0TIME STEP -   7   IDTG -92100118
1
 TS= 13141 YEAR=   0.75 DAY=273.8 ENERGY= 7.506628E-01 DTEMP= 2.724768E-08 DSALT=
5.688433E-13 SCANS= 7
 TS= 13142 YEAR=   0.75 DAY=273.8 ENERGY= 7.506628E-01 DTEMP= 2.674181E-08 DSALT=
4.983992E-13 SCANS= 7
 TS= 13143 YEAR=   0.75 DAY=273.8 ENERGY= 7.507027E-01 DTEMP= 2.680039E-08 DSALT=
5.067210E-13 SCANS= 7
 TS= 13144 YEAR=   0.75 DAY=273.8 ENERGY= 7.507432E-01 DTEMP= 2.673130E-08 DSALT=
5.006573E-13 SCANS= 3
 TS= 13145 YEAR=   0.75 DAY=273.9 ENERGY= 7.507864E-01 DTEMP= 2.675298E-08 DSALT=
5.048715E-13 SCANS= 3
 TS= 13146 YEAR=   0.75 DAY=273.9 ENERGY= 7.508296E-01 DTEMP= 2.663977E-08 DSALT=
4.980868E-13 SCANS= 4

 NO OF ITERATIONS ARE: 487
 MAX ERROR FOR U AND V: 0.49771E-05

 NO OF ITERATIONS ARE: 397
 MAX ERROR FOR U AND V: 0.49661E-05

 NO OF ITERATIONS ARE: 250
 MAX ERROR FOR U AND V: 0.49881E-05

 SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE,   MAX CHANGE
    188.596731798   74.8683730357   1.38760318151
0TIME STEP -   8   IDTG -92100121
1OUTPUT FOR DTG - 92100121   STEP -   8
0TOTAL ICE THICKNESS -   21800.5586261
 NET ICE THICKNESS -   -0.116415321827E-09

Screen output from Test Case 1   Page 5 of 5

OUTFLOW FOR THIS TIME STEP   0.0000E+00
NET OUTFLOW   0.0000E+00

ICE GROWTH FOR THIS TIME STEP 0.2251E+01
NET ICE GROWTH   0.2251E+01
OPEN WATER GROWTH 0.2231E+00
NET OPEN WATER GROWTH   0.2231E+00
OPEN WATER GROWTH 0.1449E+05
NET OPEN WATER GROWTH   0.1449E+05
1
TS= 13147 YEAR=   0.75 DAY=273.9 ENERGY= 7.509122E-01 DTEMP= 2.087434E-08 DSALT=
5.665902E-13 SCANS= 12
TS= 13148 YEAR=   0.75 DAY=273.9 ENERGY= 7.509122E-01 DTEMP= 2.034416E-08 DSALT=
4.983464E-13 SCANS= 12
TS= 13149 YEAR=   0.75 DAY=273.9 ENERGY= 7.509481E-01 DTEMP= 2.040935E-08 DSALT=
5.065423E-13 SCANS= 9
TS= 13150 YEAR=   0.75 DAY=274.0 ENERGY= 7.509846E-01 DTEMP= 2.033685E-08 DSALT=
4.994043E-13 SCANS= 7
TS= 13151 YEAR=   0.75 DAY=274.0 ENERGY= 7.510199E-01 DTEMP= 2.036895E-08 DSALT=
5.045547E-13 SCANS= 7
TS= 13152 YEAR=   0.75 DAY=274.0 ENERGY= 7.510557E-01 DTEMP= 2.034174E-08 DSALT=
5.022208E-13 SCANS= 2
STOP

Appendix B

OUTPUT PLOTS FROM TEST CASE 1

Fig. B-1 — Geostrophic wind velocity for day 1

ICE THICKNESS (m)   92100100

CONTOUR FROM 0.20000 TO 6.0000 CONTOUR INTERVAL OF 0.20000 PT (3.3) = 0
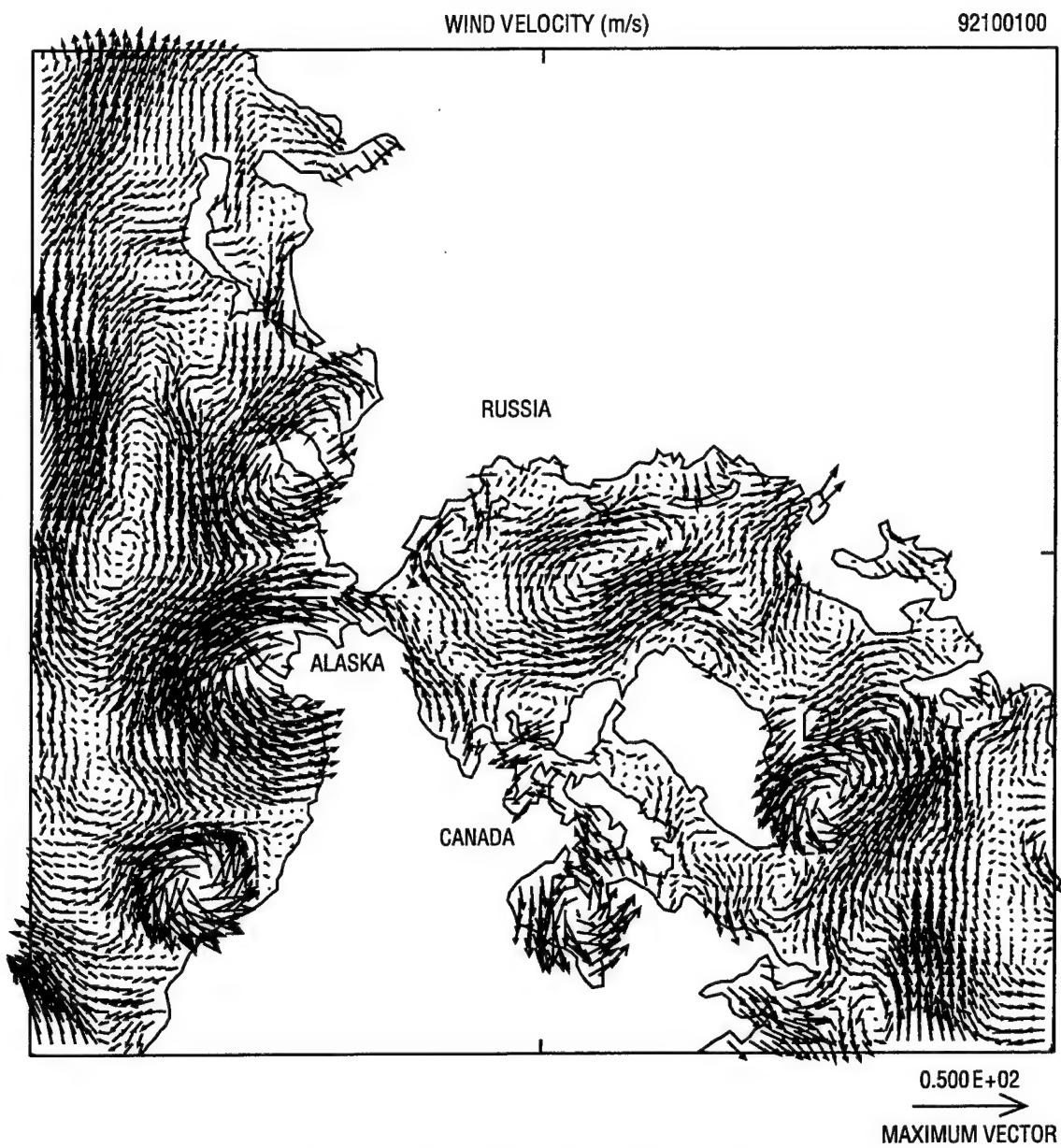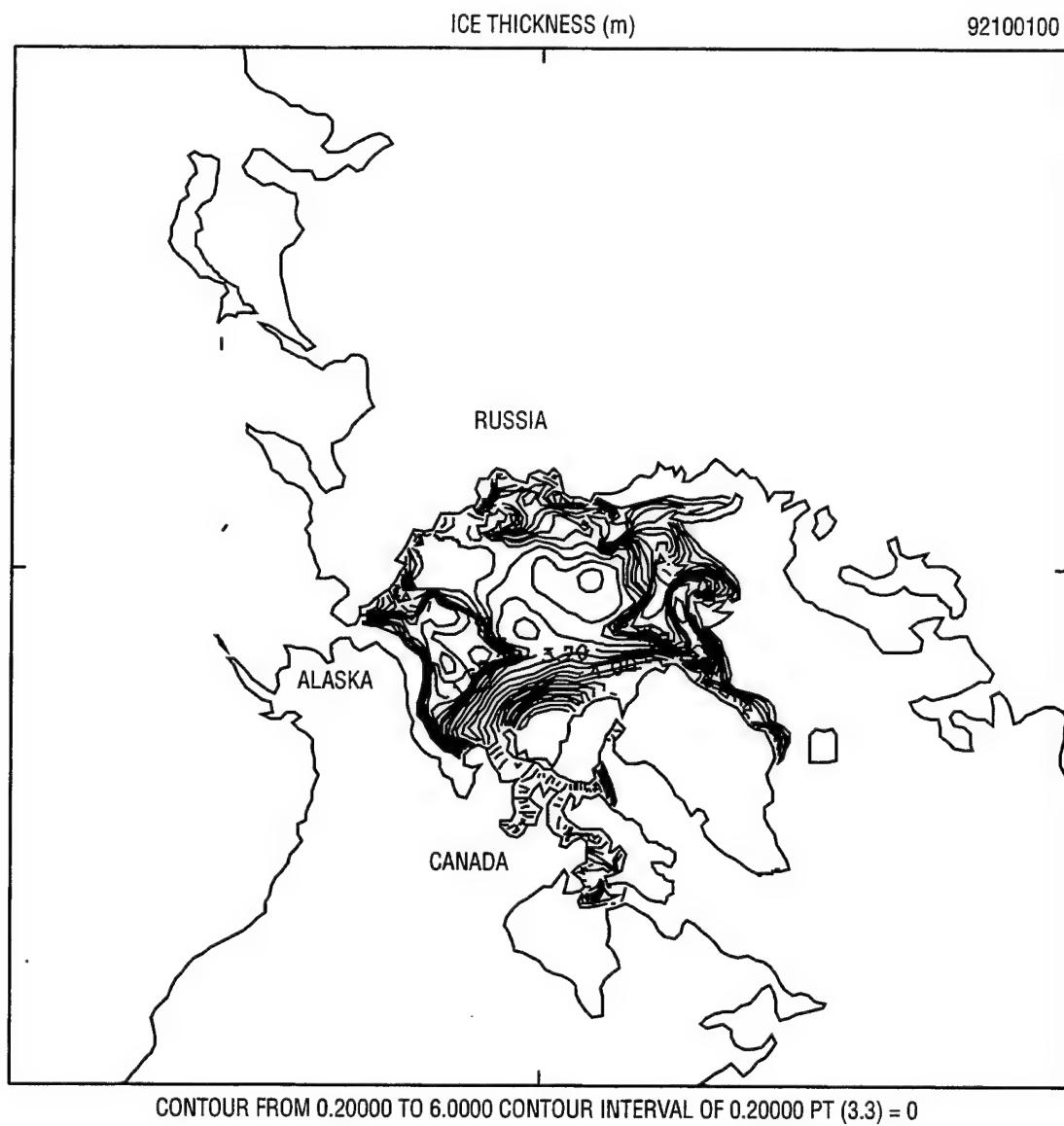
Fig. B-2 — Ice thickness for day 1

Fig. B-3 — Ice velocity for day 1

ICE CONCENTRATION   92100100

RUSSIA

ALASKA

CANADA

CONTOUR FROM 0.20000 TO 1.0000 CONTOUR INTERVAL OF 0.10000 PT (3.3) = 0

Fig. B-4 — Ice concentration for day 1

OCEAN CURRENT (15 m)   10/01/92

RUSSIA

ALASKA

CANADA

0.200 E+02
⟶
MAXIMUM VECTOR

Fig. B-5 — Ocean current for day 1

TEMPERATURE AT 15 m   92100100

CONTOUR FROM −2.0000 TO 28.000 CONTOUR INTERVAL OF 1.0000 PT (3.3) = 23.069
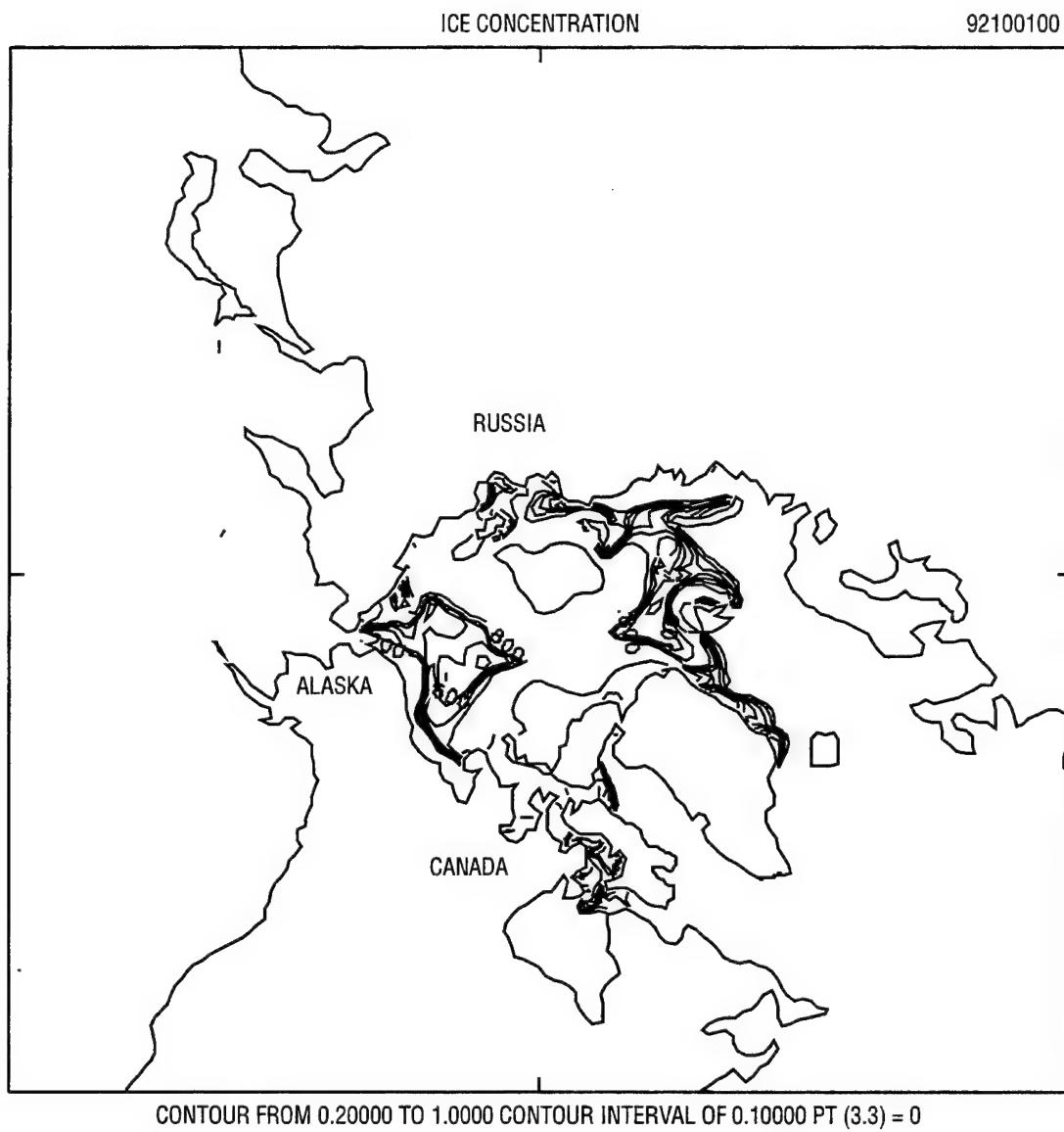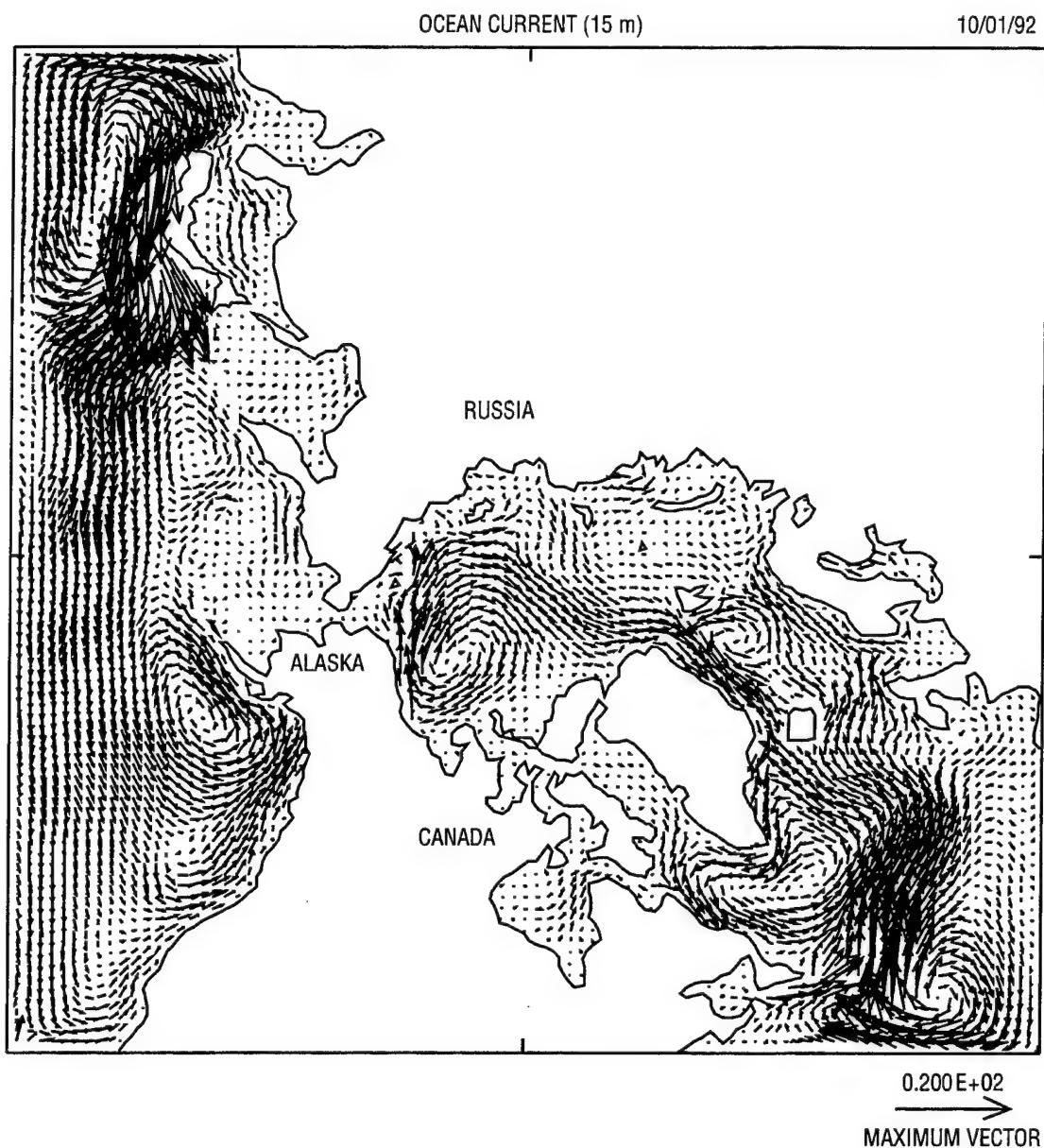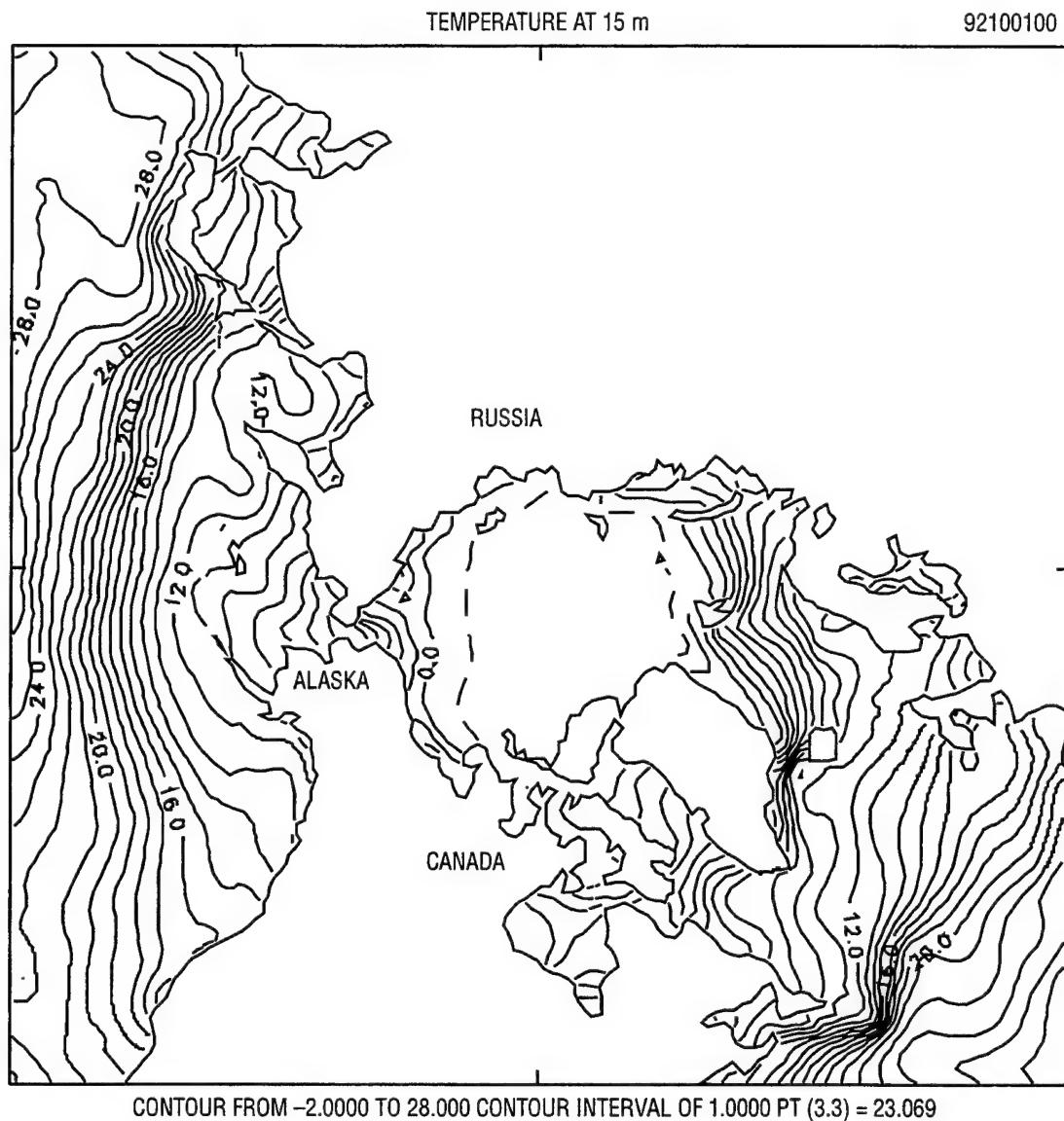
Fig. B-6 — Ocean temperature for day 1

Appendix C

RUN SHELLSCRIPT FOR TEST CASE 1

pips2_testcase_1.com

```
#
assign -R
assign -F f77 -N ieee u:10
assign -F f77 -N ieee u:11
assign -F f77 -N ieee u:12
assign -F f77 -N ieee u:13
assign -F f77 -N ieee u:14
assign -F f77 -N ieee u:15
#
assign -F f77 -N ieee u:30
assign -F f77 -N ieee u:31
#
ln   for018_tu_10.dat        fort.10
ln   for018_su_10.dat        fort.11
ln   p921001u.dat            fort.12
ln   for010_09d_u2.dat       fort.13
ln   newlatu.dat             fort.14
ln   mask_u.dat              fort.15
ln   920930d_u.res           fort.16
ln   fort_09.21              fort.18
ln   river_oct.dat           fort.19
#
pips2_-c.out <<'EOD'
 8  8  8  1  92100100              !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv   fort.30    for010_1001_final.dat
mv   fort.31    921001_final.dat
mv   fort.33    921001_final.res
mv   fort.34    fort_921001_final.21
exit
```

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Appendix D

FILE FORMATS FOR PLOTTING

File formats for the graphics output file YYMMDD_final.dat, and the ocean model currents file for010_MMDD_final.dat, are shown below. See Table 2 for descriptions of the plots to be generated.

GRAPHICS FILE FORMAT *YYMMDD.dat*		
File Access Method: unformatted, sequential access		
Data Stored in File:		
Record	**Data**	**Description**
1	GAIRX(IMTP1,JJMTP1)	x component of the wind, where IMTP1, JMTP1 are the dimensions of the wind field
2	GAIRY(IMTP1,JMTP1)	y component of the wind
3	HEFF(IMT,JMT)	mean ice thickness per grid cell, where IMT, JMT are the dimensions of the thermodynamic field
4	UICE(IMTP1,JMTP1)	x component of the ice drift
5	VICE(IMTP1,JMTP1)	y component of the ice drift
6	AREA1(IMT,JMT)	ice mass per grid area

OCEAN CURRENTS FILE FORMAT for 010_*mmdd*.dat		
File Access Method: unformatted, sequential access		
Data Stored in File:		
Record	**Data**	**Description**
2 records for 2 to JMTM1	J1, ITT	present timestep meridional gridpoint index, timestep counter
	UTEMP(IMT),VTEMP(IMT), TMP(IMT,2)	present timestep x component, y component of ocean current, temperature, salinity
2 records for 2 to JMTM1	J1, ITT	previous timestep meridional gridpoint index, timestep counter
	UTEMP(IMT),VTEMP(IMT), TMP(IMT,2)	previous timestep x component, y component of ocean current, temperature, salinity
	GICE, SHICE, FW1	ice thickness growth rate of open water, total ice thickness, heat above freezing

Appendix E

SCREEN OUTPUT FROM TEST CASE 2

```
Skipping... --------------------------------------------------------------- Day 2
0TIME STEP -      1      IDTG -92100200
 1
 TS= 13153  YEAR=   0.75  DAY=274.0  ENERGY= 7.511206E-01  DTEMP= 2.082268E-08  DSALT=
5.986000E-13  SCANS=  9
Skipping...
0TIME STEP -      2      IDTG -92100203
 1
 TS= 13159  YEAR=   0.75  DAY=274.1  ENERGY= 7.513016E-01  DTEMP= 2.286396E-08  DSALT=
5.788567E-13  SCANS= 11
Skipping...
0TIME STEP -      3      IDTG -92100206 1
 TS= 13165  YEAR=   0.75  DAY=274.3  ENERGY= 7.514662E-01  DTEMP= 2.759143E-08  DSALT=
5.836265E-13  SCANS=  5
Skipping...
0TIME STEP -      4      IDTG -92100209
 1
 TS= 13171  YEAR=   0.75  DAY=274.4  ENERGY= 7.516268E-01  DTEMP= 2.552282E-08  DSALT=
5.963231E-13  SCANS=  3
Skipping...
0TIME STEP -      5      IDTG -92100212
 1
 TS= 13177  YEAR=   0.75  DAY=274.5  ENERGY= 7.517591E-01  DTEMP= 2.747135E-08  DSALT=
5.950183E-13  SCANS=  5
Skipping...
0TIME STEP -      6      IDTG -92100215
 1
 TS= 13183  YEAR=   0.75  DAY=274.6  ENERGY= 7.518779E-01  DTEMP= 2.459285E-08  DSALT=
5.951503E-13  SCANS=  5
Skipping...
0TIME STEP -      7      IDTG -92100218
 1
 TS= 13189  YEAR=   0.75  DAY=274.8  ENERGY= 7.519474E-01  DTEMP= 2.529425E-08  DSALT=
6.000485E-13  SCANS=  8
Skipping...
0TIME STEP -      8      IDTG -92100221
1OUTPUT FOR DTG - 92100221      STEP -          8
0TOTAL ICE THICKNESS -    21810.6851277
 NET ICE THICKNESS -      0.000000000000E+00
```

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```
OUTFLOW FOR THIS TIME STEP   0.0000E+00
NET OUTFLOW     0.0000E+00

ICE GROWTH FOR THE TIME STEP 0.3126E+01
NET ICE GROWTH     0.3126E+01
OPEN WATER GROWTH  0.5390E+00
NET OPEN WATER GROWTH   0.5390E+00
OPEN WATER GROWTH  0.1450E+05
NET OPEN WATER GROWTH   0.1450E+05
 1
 TS= 13195  YEAR=   0.75  DAY=274.9  ENERGY= 7.520047E-01  DTEMP= 1.863790E-08  DSALT=
6.062751E-13  SCANS= 5
```
Skipping...
```
STOP executed at line 641 in Fortran routine 'DRIVER'
```
Skipping... -- Day 3
```
0TIME STEP -     1     IDTG -92100300
 1
 TS= 13201  YEAR=   0.75  DAY=275.0  ENERGY= 7.521201E-01  DTEMP= 2.010657E-08  DSALT=
6.397140E-13  SCANS= 8
```
Skipping...
```
0TIME STEP -     2     IDTG -92100303
 TS= 13207  YEAR=   0.75  DAY=275.1  ENERGY= 7.523322E-01  DTEMP= 2.203298E-08  DSALT=
6.209074E-13  SCANS= 6
```
Skipping...
```
0TIME STEP -     3     IDTG -92100306
 1
 TS= 13213  YEAR=   0.75  DAY=275.3  ENERGY= 7.525339E-01  DTEMP= 2.671875E-08  DSALT=
6.230552E-13  SCANS= 6
```
Skipping...
```
0TIME STEP -     4     IDTG -92100309
 1
 TS= 13219  YEAR=   0.75  DAY=275.4  ENERGY= 7.527034E-01  DTEMP= 2.464994E-08  DSALT=
6.338714E-13  SCANS= 5
```
Skipping...
```
0TIME STEP -     5     IDTG -92100312
 TS= 13225  YEAR=   0.75  DAY=275.5  ENERGY= 7.528201E-01  DTEMP= 2.678573E-08  DSALT=
6.361652E-13  SCANS= 6
```
Skipping...
```
0TIME STEP -     6     IDTG -92100315
 1
 TS= 13231  YEAR=   0.75  DAY=275.6  ENERGY= 7.529346E-01  DTEMP= 2.379098E-08  DSALT=
6.304884E-13  SCANS= 4
```
Skipping...
```
0TIME STEP -     7     IDTG -92100318
 1
 TS= 13237  YEAR=   0.76  DAY=275.8  ENERGY= 7.530127E-01  DTEMP= 2.458737E-08  DSALT=
6.382469E-13  SCANS= 4
```
Skipping...
```
0TIME STEP -     8     IDTG -92100321
1OUTPUT FOR DTG - 92100321     STEP -          8
0TOTAL ICE THICKNESS -   21822.2107373
 NET ICE THICKNESS -      0.000000000000E+00
```

OUTFLOW FOR THIS TIME STEP   0.0000E+00
NET OUTFLOW   0.0000E+00

ICE GROWTH FOR THIS TIME STEP 0.3594E+01
NET ICE GROWTH   0.3594E+01
OPEN WATER GROWTH 0.3597E+00
NET OPEN WATER GROWTH   0.3597E+00
OPEN WATER GROWTH 0.1450E+05
NET OPEN WATER GROWTH   0.1450E+05
  1
TS= 13243 YEAR=   0.76 DAY=275.9 ENERGY= 7.530591E-01 DTEMP= 1.762976E-08 DSALT=
6.494574E-13 SCANS= 7
Skipping...
STOP
Skipping... ---Day 4
0TIME STEP -   1   IDTG -92100400
  1
TS= 13249 YEAR=   0.76 DAY=276.0 ENERGY= 7.530519E-01 DTEMP= 2.101294E-08 DSALT=
6.611956E-13 SCANS= 6
Skipping...
0TIME STEP -   2   IDTG -92100403
  1
TS= 13255 YEAR=   0.76 DAY=276.1 ENERGY= 7.530418E-01 DTEMP= 2.153834E-08 DSALT=
6.558387E-13 SCANS= 6
Skipping...
0TIME STEP -   3   IDTG -92100406
  1
TS= 13261 YEAR=   0.76 DAY=276.3 ENERGY= 7.530891E-01 DTEMP= 2.562912E-08 DSALT=
6.584157E-13 SCANS= 8
Skipping...
0TIME STEP -   4   IDTG -92100409
  1
TS= 13267 YEAR=   0.76 DAY=276.4 ENERGY= 7.532129E-01 DTEMP= 2.457216E-08 DSALT=
6.729132E-13 SCANS= 6
Skipping...
0TIME STEP -   5   IDTG -92100412
  TS= 13273 YEAR=   0.76 DAY=276.5 ENERGY= 7.533696E-01 DTEMP= 2.661560E-08 DSALT=
6.605290E-13 SCANS= 6
Skipping...
0TIME STEP -   6   IDTG -92100415
  1
TS= 13279 YEAR=   0.76 DAY=276.6 ENERGY= 7.535489E-01 DTEMP= 2.374561E-08 DSALT=
6.543791E-13 SCANS= 8
Skipping...
0TIME STEP -   7   IDTG -92100418
  1
TS= 13285 YEAR=   0.76 DAY=276.8 ENERGY= 7.537497E-01 DTEMP= 2.538295E-08 DSALT=
6.544780E-13 SCANS= 9
Skipping...
0TIME STEP -   8   IDTG -92100421
1OUTPUT FOR DTG - 92100421   STEP -   8
0TOTAL ICE THICKNESS -   21836.3388781
NET ICE THICKNESS -   0.000000000000E+00

```
OUTFLOW FOR THIS TIME STEP    0.0000E+00
NET OUTFLOW      0.0000E+00

ICE GROWTH FOR THIS TIME STEP  0.3941E+01
NET ICE GROWTH      0.3941E+01
OPEN WATER GROWTH  0.4080E+00
NET OPEN WATER GROWTH   0.4080E+00
OPEN WATER GROWTH  0.1451E+05
NET OPEN WATER GROWTH    0.1451E+05
 1
TS= 13291  YEAR=   0.76  DAY=276.9  ENERGY= 7.539827E-01  DTEMP= 1.804933E-08  DSALT=
6.585811E-13  SCANS=  8
 Skipping...
STOP
 Skipping... --------------------------------------------------------------------- Day 5
0TIME STEP -      1      IDTG -92100500
 1
TS= 13297  YEAR=   0.76  DAY=277.0  ENERGY= 7.541512E-01  DTEMP= 2.057497E-08  DSALT=
6.632686E-13  SCANS=  7
 Skipping...
0TIME STEP -      2      IDTG -92100503
 1
TS= 13303  YEAR=   0.76  DAY=277.1  ENERGY= 7.542590E-01  DTEMP= 2.063420E-08  DSALT=
6.511868E-13  SCANS=  9
 Skipping...
0TIME STEP -      3      IDTG -92100506
TS= 13309  YEAR=   0.76  DAY=277.3  ENERGY= 7.544229E-01  DTEMP= 2.456062E-08  DSALT=
6.440744E-13  SCANS=  7
 Skipping...
0TIME STEP -      4      IDTG -92100509
 1
TS= 13315  YEAR=   0.76  DAY=277.4  ENERGY= 7.546550E-01  DTEMP= 2.324119E-08  DSALT=
6.407560E-13  SCANS=  6
 Skipping...
0TIME STEP -      5      IDTG -92100512
 1
TS= 13321  YEAR=   0.76  DAY=277.5  ENERGY= 7.549248E-01  DTEMP= 2.559010E-08  DSALT=
6.486002E-13  SCANS=  7
 Skipping...
0TIME STEP -      6      IDTG -92100515
 1
TS= 13327  YEAR=   0.76  DAY=277.6  ENERGY= 7.552267E-01  DTEMP= 2.269537E-08  DSALT=
6.434174E-13  SCANS=  9
 Skipping...
0TIME STEP -      7      IDTG -92100518
 1
TS= 13333  YEAR=   0.76  DAY=277.8  ENERGY= 7.555203E-01  DTEMP= 2.445058E-08  DSALT=
6.609702E-13  SCANS=  9
 Skipping...
0TIME STEP -      8      IDTG -92100521
1OUTPUT FOR DTG - 92100521      STEP -          8
0TOTAL ICE THICKNESS -     21853.1228443
 NET ICE THICKNESS -       0.000000000000E+00
```

```
OUTFLOW FOR THIS TIME STEP    0.0000E+00
NET OUTFLOW     0.0000E+00

ICE GROWTH FOR THIS TIME STEP  0.3655E+01
NET ICE GROWTH     0.3655E+01
OPEN WATER GROWTH  0.3352E+00
NET OPEN WATER GROWTH    0.3352E+00
OPEN WATER GROWTH  0.1452E+05
NET OPEN WATER GROWTH    0.1452E+05
1
TS= 13339  YEAR=   0.76  DAY=277.9  ENERGY= 7.557604E-01  DTEMP= 1.949153E-08  DSALT=
6.507655E-13  SCANS= 27
Skipping...
STOP
```

Appendix F

OUTPUT PLOTS FROM TEST CASE 2
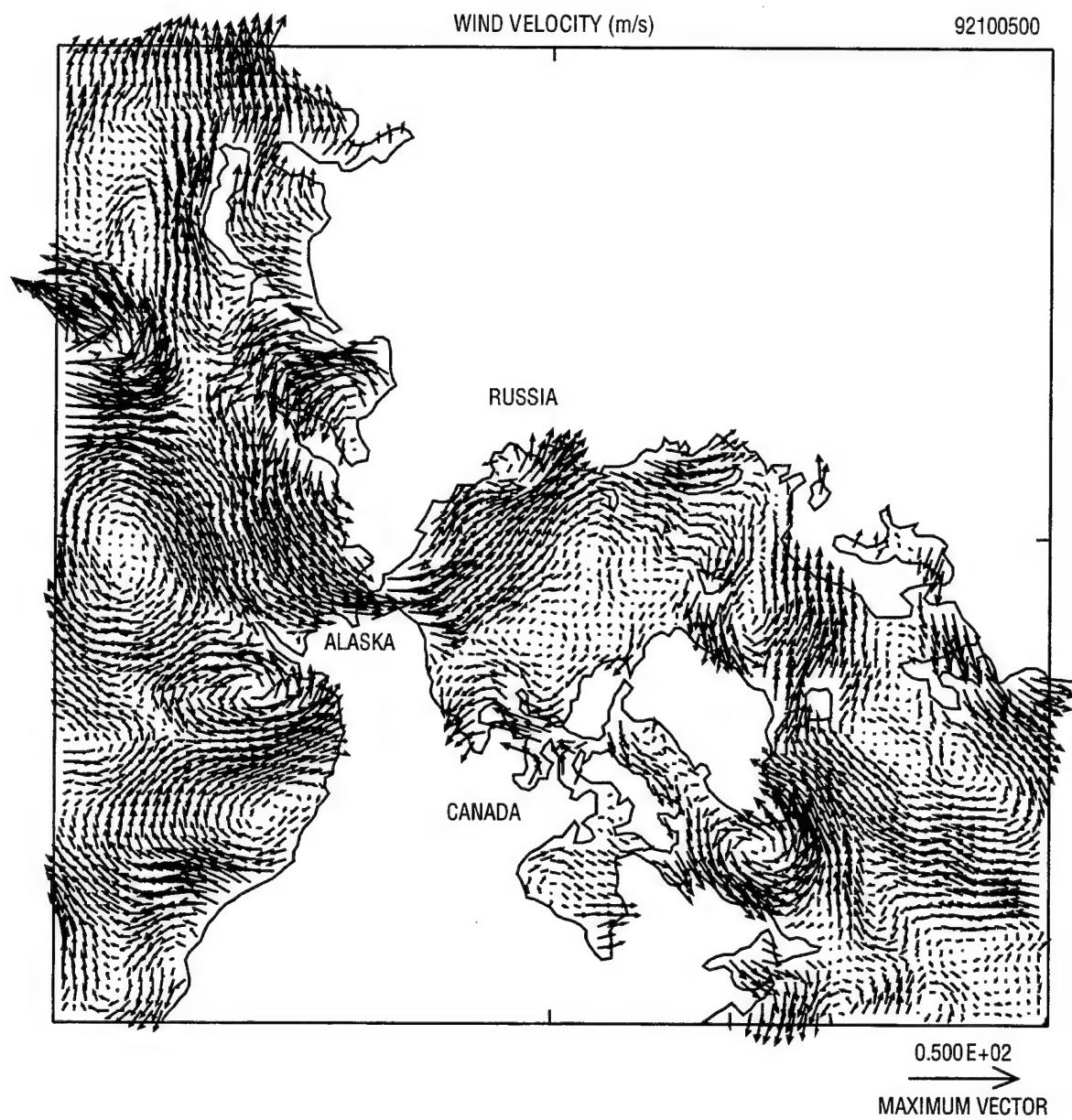

Fig. F-1 — Geostrophic wind velocity for day 5

ICE THICKNESS (m)　　　　　　　　　　　　　　　　　　92100500

RUSSIA

ALASKA

CANADA

CONTOUR FROM 0.20000 TO 6.0000 CONTOUR INTERVAL OF 0.20000 PT (3.3) = 0

Fig. F-2 — Ice thickness for day 5

ICE VELOCITY (cm/s)   92100500

RUSSIA

ALASKA

CANADA

0.300 E+02

MAXIMUM VECTOR

Fig. F-3 — Ice velocity for day 5

ICE CONCENTRATION   92100500

CONTOUR FROM 0.20000 TO 1.0000 CONTOUR INTERVAL OF 0.10000 PT (3.3) = 0
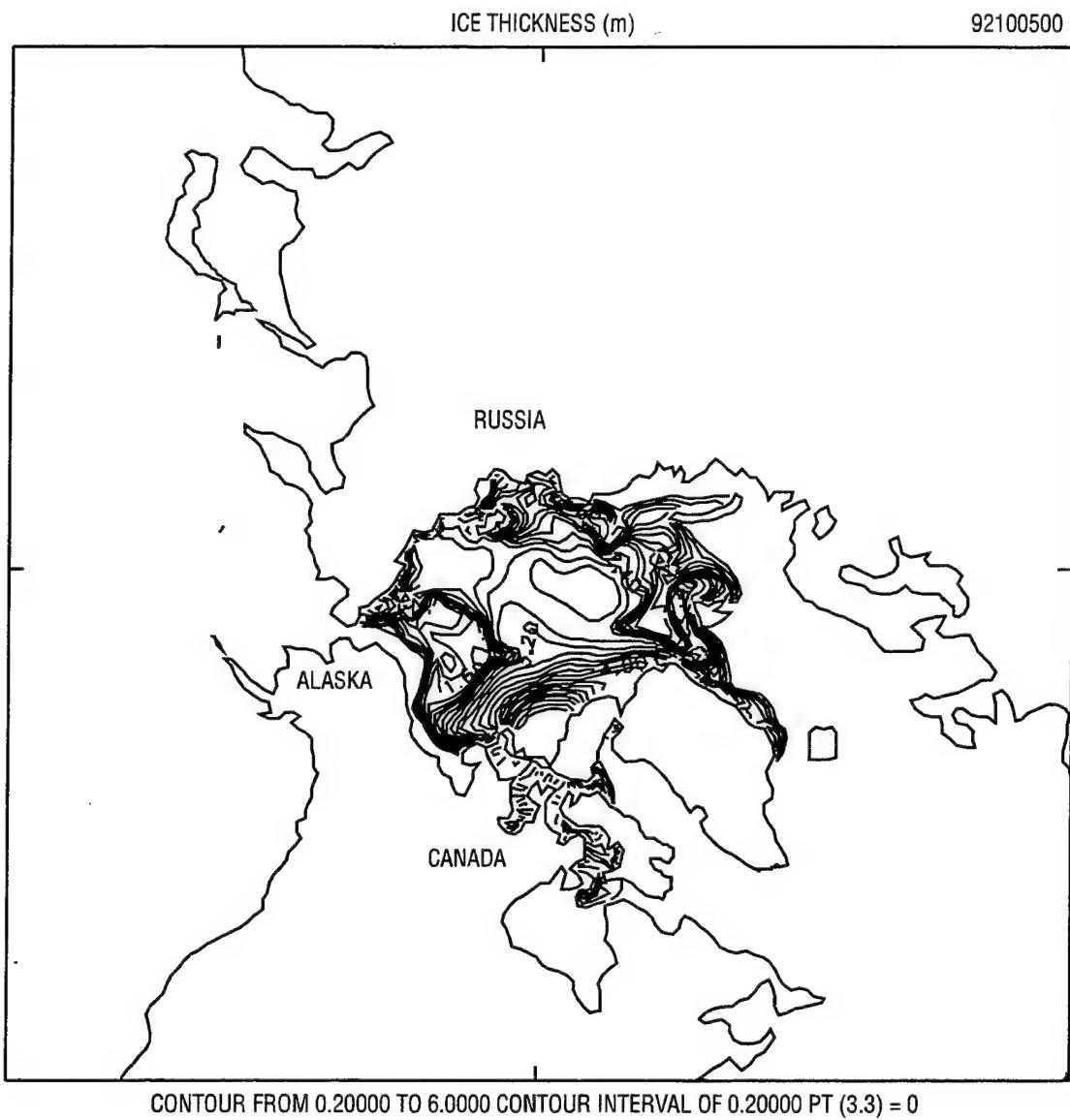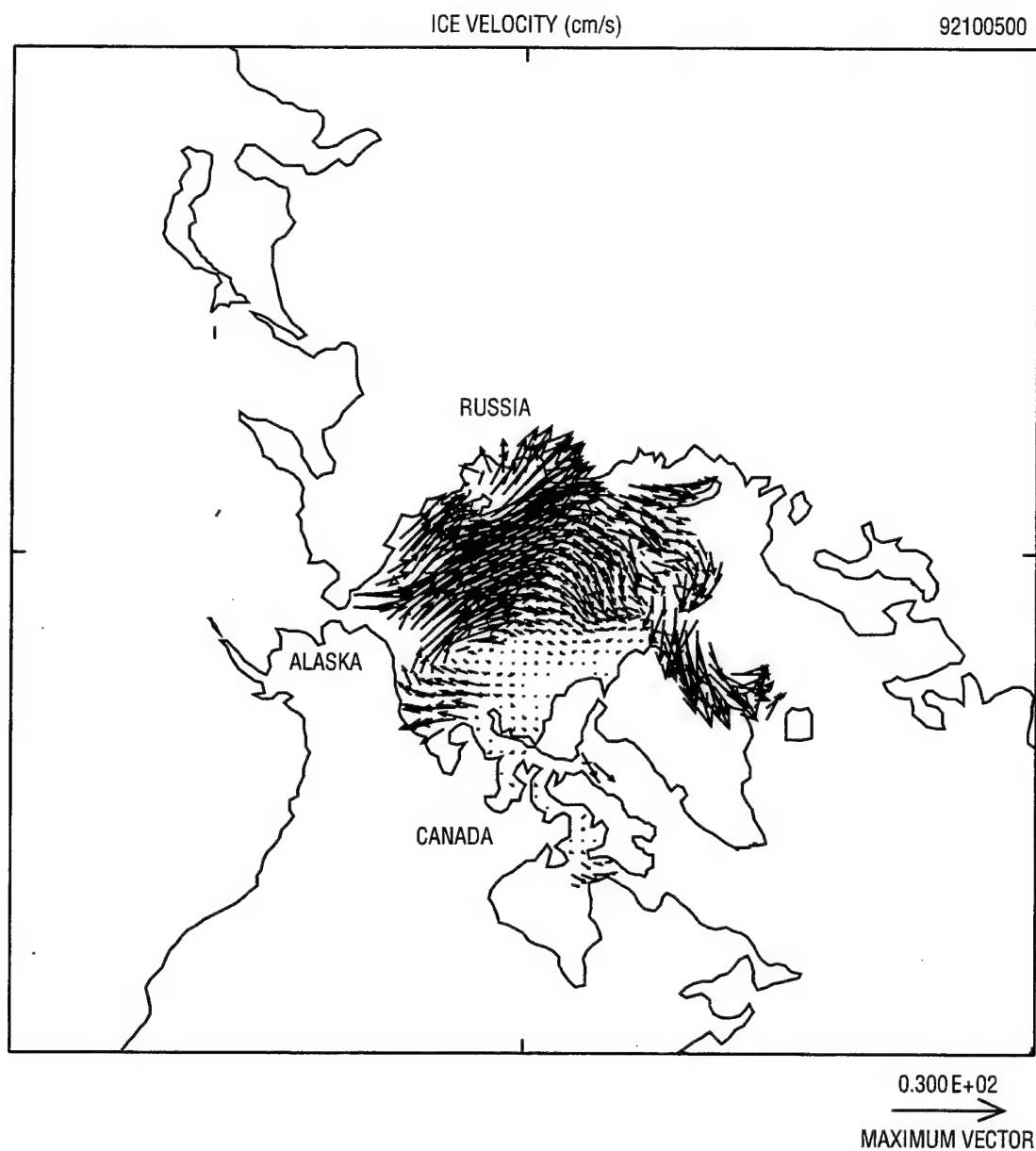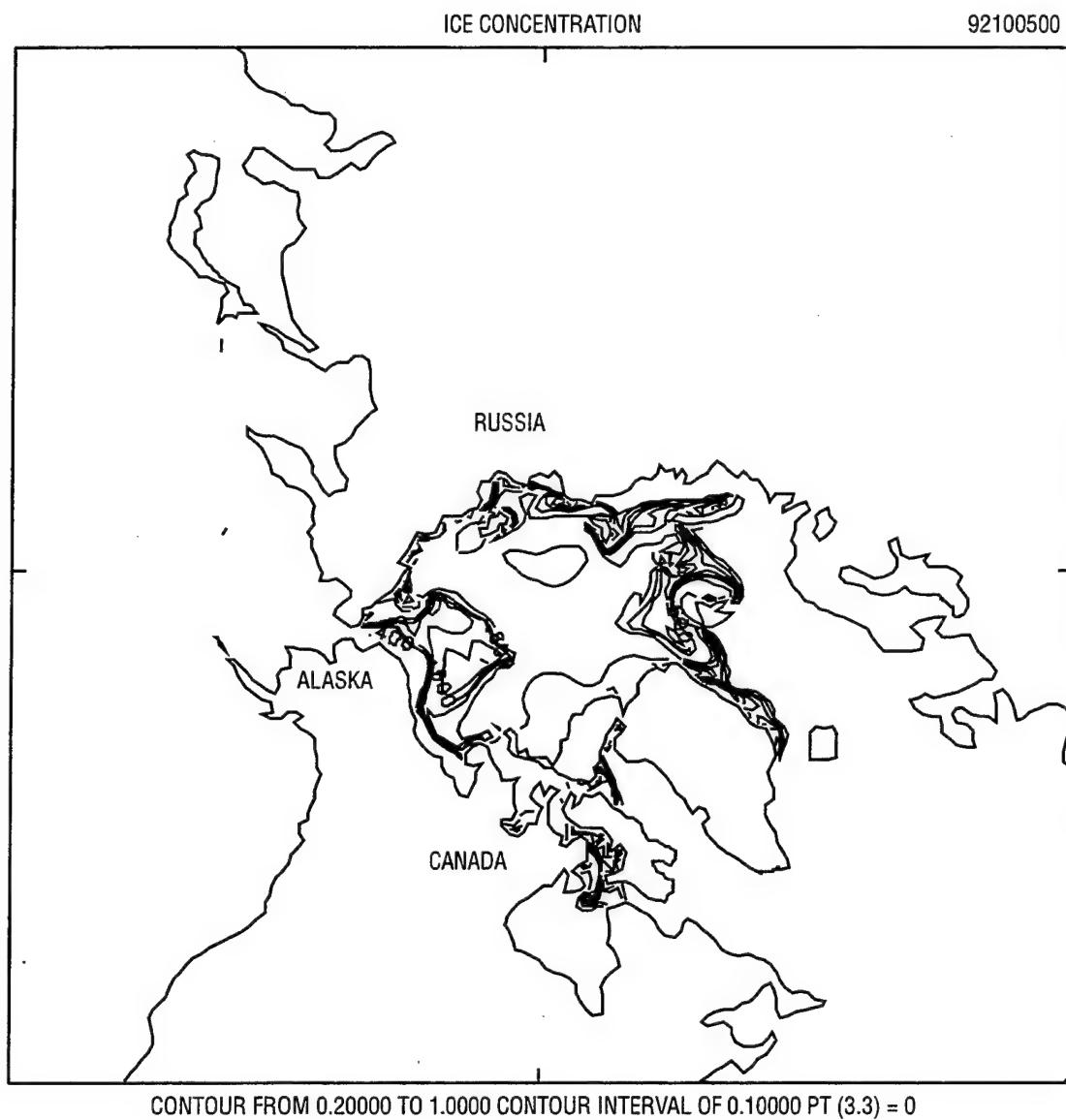
Fig. F-4 — Ice concentration for day 5

Fig. F-5 — Ocean current for day 5

TEMPERATURE AT 15 m   92100500

CONTOUR FROM −2.0000 TO 28.000 CONTOUR INTERVAL OF 1.0000 PT (3.3) = 23.318
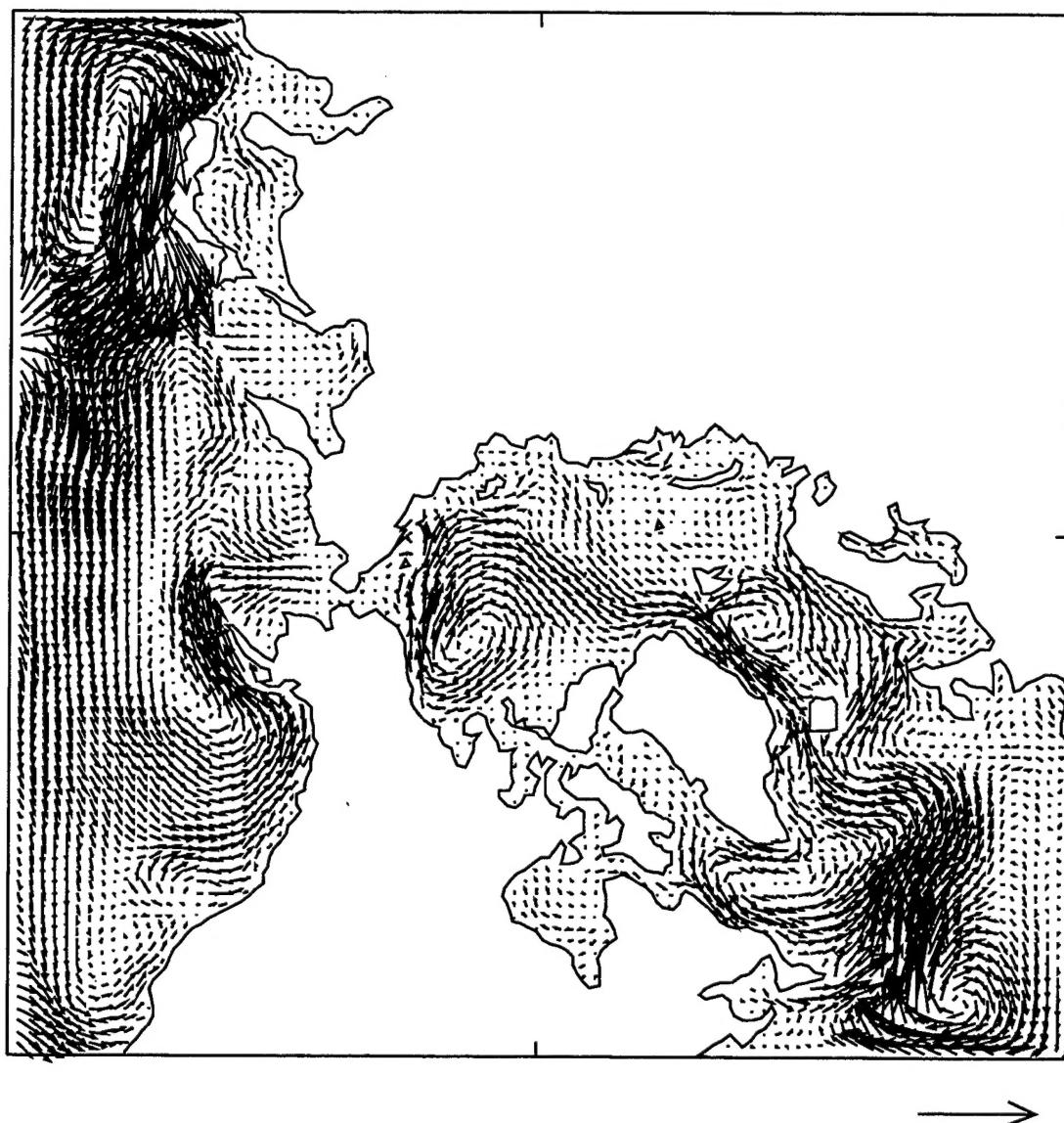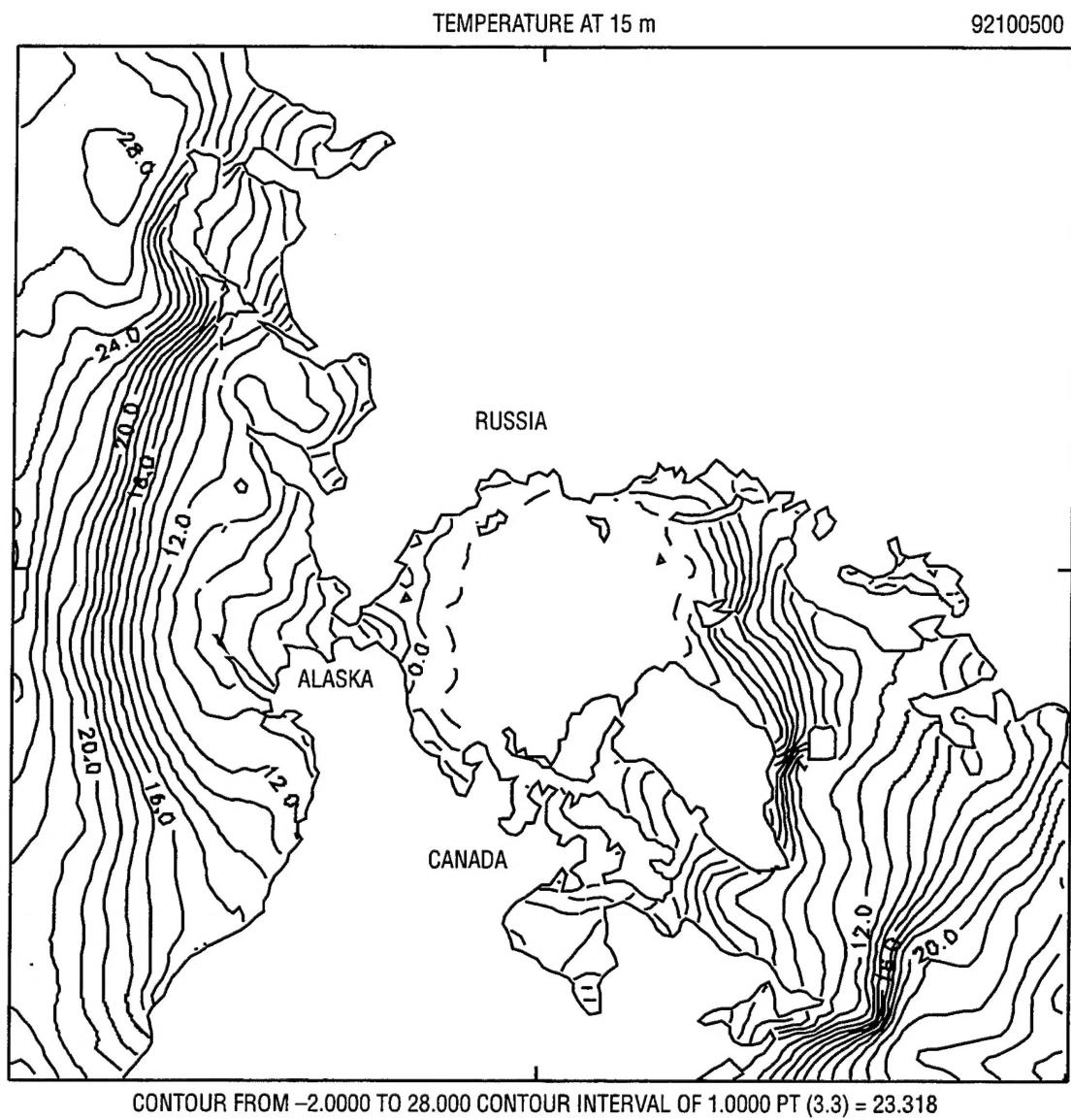
Fig. F-6 — Ocean temperature for day 5

Appendix G

RUN SHELLSCRIPT FOR TEST CASE 2

```
#
#     Run 1:  Day 2 - October 2, 1992
#
assign -R
assign -F f77 -N ieee u:10
assign -F f77 -N ieee u:11
assign -F f77 -N ieee u:12
assign -F f77 -N ieee u:13
assign -F f77 -N ieee u:14
assign -F f77 -N ieee u:15
#
assign -F f77 -N ieee u:30
assign -F f77 -N ieee u:31
#
ln   for018_tu_10.dat        fort.10
ln   for018_su_10.dat        fort.11
ln   p921002u.dat            fort.12
ln   for010_1001_final.dat   fort.13
ln   newlatu.dat             fort.14
ln   mask_u.dat              fort.15
ln   921001_final.res        fort.16
ln   fort_921001_final.21    fort.18
ln   river_oct.dat           fort.19
#
#
pips2_c.out <<'EOD'
 8  8  8 1  92100200              !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv   fort.30    for010_1002_final.dat
mv   fort.31    921002_final.dat
mv   fort.33    921002_final.res
mv   fort.34    fort_921002_final.21
#
#     Run 2:  Day 3 - October 3, 1992
#
ln   p921003u.dat            fort.12
ln   for010_1002_final.dat   fort.13
ln   921002_final.res        fort.16
```

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```
ln   fort_921002_final.21        fort.18
#
#
pips2_c.out <<'EOD'
 8  8  8 1  92100300              !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv  fort.30    for010_1002_final.dat
mv  fort.31    921003_final.dat
mv  fort.33    921003_final.res
mv  fort.34    fort_921003_final.21
#
#
#    Run 3:  Day 4 - October 4, 1992
#
ln   p921004u.dat             fort.12
ln   for010_1003_final.dat    fort.13
ln   921003_final.res         fort.16
ln   fort_921003_final.21     fort.18
#
pips2_c.out <<'EOD'
 8  8  8 1  92100400              !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv  fort.30    for010_1004_final.dat
mv  fort.31    921004_final.dat
mv  fort.33    921004_final.res
mv  fort.34    fort_921004_final.21
#
#    Run 4:  Day 5 - October 5, 1992
#
ln   p921005u.dat             fort.12
ln   for010_1004_final.dat    fort.13
ln   921004_final.res         fort.16
ln   fort_921004_final.21     fort.18
#
pips2_c.out <<'EOD'
 8  8  8 1  92100500              !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv  fort.30    for010_1005_final.dat
mv  fort.31    921005_final.dat
mv  fort.33    921005_final.res
mv  fort.34    fort_921005_final.21

exit
```